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Using a four-step heuristic algorithm to design personalized day tour route within a tourist attraction

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HIGHLIGHTS

- A tourist recommendation system is developed to design personalized day tour routes.
- We propose a four-step heuristic algorithm based on a GA and a DEA.
- A case study at Jiuzhai Valley is conducted to evaluate the performance.
- The system could design more personalized and realistic day tour routes for tourists.

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ABSTRACT

The design of personalized day-tour routes for tourists plays a fundamental role in improving tourists' travel experiences, and it is a crucial practice for managers of tourist attractions in an increasingly competitive marketplace. This study constructs a tourist recommendation system with consideration for aesthetic fatigue and variable sightseeing value. A four-step heuristic algorithm (involving a genetic algorithm and a difference evolution algorithm) is proposed, which serves as the nucleus for a new system to deal with the tourist trip design problem. To evaluate the performance of this algorithm, a case study was conducted at the Jiuzhai Valley in Sichuan, China. The results of paired sample t-tests indicated that the proposed heuristic algorithm indeed performed significantly better than existing methods. Furthermore, the study showed that our proposed system was able to design more realistic and better personalized routes for tourists than previous systems.

1. Introduction

Day tours provide a primary means for many tourists to explore tourist attractions in a convenient and cost-effective way (Holloway, 1981; Ryan & Gu, 2007). This mode of travel is especially popular at tourist attractions where the visitors pay by the day, such as theme parks or national parks. However, a tourist attraction usually contains numerous interconnected points of interest (POIs, e.g., scenic spots, activities or shows) (Leiper, 1990), and it is often impossible for tourists to visit all of the POIs during the limited time of their day tour (Tsai & Chung, 2012). Therefore, the tourists have to make a selection of which POIs they feel are the most valuable (Souffriau, Vansteenwegen, Vertommen, Berghe, & Oudheusden, 2008). Then the tourists have to determine the sequencing and time allocation for their day tour. This problem has been denoted as the "tourist trip design problem" (TTDP) (Vansteenwegen & Van Oudheusden, 2007). For the managers of tourist attraction sites, the TTDP involves the challenge of planning varied routes for tourists who are interested in visiting multiple POIs, and maximizing their entertainment value while taking a multitude of constraints into account.

To meet the challenge of improving tourist experience, it is fundamental to provide visitors with tour routes that are best suited to their particular needs (Wong & McKercher, 2012). Providing such quality experience is increasingly crucial for tourist attractions because they face an increasingly competitive marketplace (Martin & Mason, 1987), as has been shown by many studies

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(Kang & Gretzel, 2012; Uriely, 2005; Vittersø, Vorkinn, Vistad, & Vaagland, 2000). Presently, some tourist attractions provide visitors with a variety of suggestions for tour routes during their visits. For example, the Summer Palace in Beijing, China, gives tips for day-tour routes, such as "*East Palace Gate – Hall of Benevolence and Longevity – … Suzhou Street.*" However, such recommendations are often outdated, and some temporary changes in the available venues may occur (e.g., POIs may be temporary closed for maintenance). More importantly, these routes are usually constructed to satisfy the interests of the majority, rather than the specific interests of individual tourists (Cheverst, Davies, Mitchell, Friday, & Efstratiou, 2000; Yeh & Cheng, 2015). Growing numbers of tourists favor personalized options rather than pre-organized routes, as there is great diversity among individual interest profiles (Hyde & Lawson, 2003; Rodríguez, Molina, Pérez, & Caballero, 2012). To obtain a personalized route, however, tourists need to collect large volumes of information and evaluate numerous possible alternatives. This task is obviously cumbersome; and the tourists may find it difficult to determine the best choices amid various conflicting options or objectives (Rodríguez et al., 2012).

Therefore, academics and practitioners have been increasingly involved in studying tourist recommendation systems (TRS) to assist tourists in making decisions as they plan their trips (Rodríguez et al., 2012). We have analyzed the existing route-planning systems, and have identified a range of issues and possibilities to consider for better selection of the routes that are well suited to each tourist.

First, the existing systems emphasize personalized POI selection and sequencing, but they determine the duration of time spent at each selected POI according to the experience of previous tourists, rather than the specific interests of the focal tourist. Clearly, each tourist may wish to spend a different amount of time at each POI. Second, most existing systems propose methods of route design which assume that tourists visit each POI only once. This assumption may be incorrect, as tourists in theme parks often make repeated visits to popular POIs (Tsai & Chung, 2012). Third, most previous models fail to consider that the time a tourist spends at a POI is typically correlated with the personal value of that attraction for the tourist concerned (Erdoğ;an & Laporte, 2013). In addition, most previous models make no allowance for aesthetic fatigue, although it is commonly observed that marginal satisfaction starts to decline with the duration time at the same POI (Kemperman, Borgers, Oppewal, & Timmermans, 2003). Last but not least, few previous studies have explored the relationship between the timing of a visit and its value for the visitor (Cheverst et al., 2000). In actuality, the sightseeing value of a POI may change over time, leading to different experiences according to the timing of a visit. For instance, when visitors come to Old Faithful Geyser in Yellowstone National Park, the moment of the geyser's eruption is far more valuable for tourists than other moments during the day. Therefore, when planning the visitation routes, it is important to optimize the timing of visits to particular POIs, according to their variable sightseeing value (VSV).

To make up for these various shortcomings of the existing systems, we propose a TRS that considers the factors of aesthetic fatigue and VSV. The nucleus of this proposed system is a new algorithm for solving the TTDP. This algorithm is necessarily complicated, due to the multiple constraints and particularities of both of the individual tourists and the particular attractions concerned. Many of the factors we evaluate have not been considered in other systems. To overcome the difficulties involved, we combine a genetic algorithm (GA) and a difference evolution algorithm (DEA), to design a four-step heuristic algorithm. This new algorithm deals with route coding, initial route construction, route set evolution and route evaluation. The proposed algorithm differs from existing methods in three major ways: (1) It applies a double-layer, variable-length chromosome approach for coding the route. (2) It uses an improved greedy algorithm to construct the initial route set. (3) It evolves the optimal tour route by combining a GA with a DEA.

To evaluate the performance of this proposed system, a case study was conducted at Jiuzhai Valley National Park in Sichuan, China. The results of paired sample t-tests indicated that the proposed heuristic algorithm indeed performed significantly better than other methods.

This study contributes to the field of personalized tourism planning by offering a more sensitive approach for solving the TTDP in the postmodern tourism era. This approach meets the challenge of a tourist market that is dominated by the demand for tailored experiences (Novelli, Schmitz, & Spencer, 2006), as tourists increasingly prefer personalized options rather than pre-organized routes (Uriely, 2005). The proposed heuristic algorithm is shown to outperform previous methods of route customization. Our approach enables a TRS that can design more realistic and more personally satisfying visitation routes for tourists.

The remainder of this study is organized as follows. In Section 2, we present an extensive literature review of previous solutions to the TTDP and other related problems. The proposed mathematical model to more successfully deal with the TTDP is established in Section 3. Section 4 explains the four-step heuristic algorithm in detail. In Section 5, the performance of the system and its heuristic algorithm is evaluated through a case study conducted at Jiuzhai Valley National Park. We summarize the findings in Section 6, and propose possible directions for future research.

2. Literature review

The tourism market has entered a mature stage, and is no longer experiencing high growth in terms of new development. Furthermore, many tourist attractions are facing increased competition from other tourism sites (Braun & Soskin, 1999; Heo & Lee, 2009). To survive in this increasingly competitive marketplace, it is crucial for tourist attractions to understand tourist behavior and to provide high-quality experiences for visitors with diverse tastes and preferences (Martin & Mason, 1987). Many studies have shown that tourists' movements within a destination are a fundamental component of tourist behavior, which in turn is directly applicable to destination management, including route design, product development, and attraction planning (Mckercher & Lau, 2008; Tideswell & Faulkner, 1999; Tsai & Chung, 2012; Xia et al., 2010; Zheng, Huang, & Li, 2017).

Recently, increasing attention has been paid to intra-destination tourist movement and the factors that influence these movement patterns (Fennell, 1996; Tideswell & Faulkner, 1999). McKercher and colleagues thoroughly explored this issue. They identified 78 discrete movement patterns, which they categorised into 11 movements styles, and concluded that the movement patterns were a reflection of the interaction of several factors (Mckercher & Lau, 2008). Lew and McKercher (2002) indicated that geographic location, travelers' life cycles, and socio-economic situations could influence how travelers used Hong Kong in their itinerary. Lew and McKercher (2006) divided the influential factors into two categories, destination characteristics and tourist characteristics, whereas Lau and McKercher (2006) divided the factors into four groups, human factors, physical factors, trip factors and time factors.

These studies have helped practitioners to understand tourist behavior and tourists' tastes and preferences, which in turn has improved the quality of tourists' experiences. Amid various efforts to improve the quality of tourists' experiences, the emerging field of